PATENT SPECIFICATION

DRAWINGS ATTACHED

900,083

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Process and apparatus for the production of perforated foils or nets of thermoplastic material.

COMPLETE SPECIFICATION

We, ROSEDALE ASSOCIATED MANUFACTURERS LIMITED, a British Company, of Treforest Works, Treforest Industrial Estate, Glamorgan, Wales, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the production of perforated foils and nets of thermoplastic material.

Nets of thermoplastic material have hitherto been produced e.g. by welding threads together net-fashion. This process is comparatively difficult to carry out and demands high accuracy in welding. In addition, this process has the disadvantage that the threads do not have their maximum strength in the nets. They are still comparatively easily stretchable, so that in the event of a rather heavy stress on the net, some parts of the threads elongate, whereby the net is deformed.

The present invention relates to a process for the production of nets of thermoplastic material and an apparatus for carrying out this process without the use of welding. By means of the process according to the invention, it is not only possible to produce nets of different degrees of fineness and with net perforations of different shapes, but foils can also be provided wtih perforations of all kinds, desirable for technical or aesthetic reasons.

According to the present invention, in a process for the production of perforated foils and nets of thermoplastic material from thermoplastic foil provided with perforations such as holes or slits, the perforated foil is stretched in a hot condition and cooled whilst still subjected to the stretching force.

The foil is preferably stretched to its condition of maximum strength.

The foil may be heated before the perforations are formed therein, and some stretching may be applied thereto before or during its perforation. Alternatively, the heating of the foil may be effected during or after perforation thereof.

The edges of the perforations in the foil may be at least partly displaced from the plane of the foil whilst the latter is in the hot condition, and may be fixed in the displaced condition by cooling.

In carrying out the process according to the invention the foil of thermoplastic material may be passed over a perforating roll which forms the perforations and then through a tension roll pair having a higher peripheral speed than the perforating roll.

The foil of thermoplastic material may be subjected to further stretching after it has been cooled, and the stretching before or after cooling may be carried out in two directions at right angles to each other, preferably in the direction of feed of the foil and in a direction at right angles thereto.

The stretching at right angles to the direction of feed of the foil may be effected by pairs of rollers, or bands passing over rollers the rollers having their axes of rotation at an acute angle to the feed direction of the foil and directed at a diverging angle to each other in the said feed direction, the said rollers or bands drawing the foil in the direction of their axes and releasing it after attaining the required degree of stretch.

The foil may be wetted with colour when in the warm or hot condition.

Apparatus for carrying out the process according to the invention may comprise a perforating roll or rolls driven at a low peripheral speed, a pair of tension rolls driven at a higher peripheral speed, means for heating the foil before, during or after its passage over or between the perforating roll or rolls and means for cooling the foil after heating and perforation and before it passes between the tension rolls.

Apparatus for carrying out the process with lateral stretching of the foil may comprise an extruder, a wide sheeting die receiving thermoplastic material from the extruder, a perforating roll pair the rolls of which are wetted by a liquid, a lateral stretching device, a longitudinal stretching device, and an after-stretching device through which the foil is passed in succession after leaving the sheeting die.

The lateral stretching device may comprise roller pairs or bands running over roller pairs arranged adjacent to the feed path of the foil, one on each side thereof, the axes of the rollers diverging in the direction of the travel of the foil and the rollers or bands being provided with means for gripping the edges of the foil.

The invention is hereinafter described with reference to the accompanying drawings, in which:—

Figure 1 shows one arrangement of apparatus for carrying out the process of the invention without lateral stretching of the foil;

Figure 2 is a section, on the line A—B of Figure 1, in the plane containing the axes of the perforating roll and its associated roll;

Figure 3 shows another arrangement of apparatus for carrying out the process of the invention in which the direction of travel of the foil is changed as it passes over the cutter roll;

Figure 4 shows one pattern of perforations in the foil before the foil is stretched, the perforations being in the form of straight slits;

Figure 5 shows the foil of Figure 4 after stretching;

Figure 6 shows another pattern of perforations in the foil before stretching, the perforations being V-shaped slits;

Figure 7 shows the foil of Figure 6 after stretching;

Figure 8 shows a pattern of perforations in the foil before stretching, the perforations being circular holes;

Figure 9 shows the foil of Figure 8 after stretching;

Figure 10 is a cross section through the foil shown in Figure 5, along the line C-D, with the edges of the perforations bent out of the plane of the foil;

Figure 11 shows an arrangement of apparatus for carrying out the process of the invention with lateral stretching of the foil; and

Figure 12 shows the lateral stretching means of Figure 11 on a larger scale and in plan view.

Referring to Figure 1, the imperforate foil 1 is passed through a roll pair, comprising the perforating roll 2, the periphery of which is provided with cutters 3, and the co-operating roll 4, the surface of which is covered with a flexible layer 5. When the foil is passed between the rolls of this pair, the cutters 3 incise in the foil perforations, the form of which depends upon the form of the cutters. For the perforations 6 shown in Figure 4, plain straight-edge cutters were used, for the perforations 7 shown in Figure , V-shaped cutters were used and for the perforations 8 shown in Figure 8 annular cutters were used. Perforations similar to those shown in Figure 8 would be obtained if simple pins were used instead of annular cutters. During the production of the perforations, the cutters strike against the flexible layer 5, the flexibility of which prevents premature wear of the cutter edges. The perforating roll or the cutters mounted thereon, may be readily interchangeable to enable the apparatus to be used for forming perforations of different shapes.

After passing the perforating roll in the direction of the arrow 9, the foil part 10 now provided with perforations is subjected to the pull exerted by the tension roll pair 11, 11. The peripheral speed of the tension roll pair 11, 11 is higher than the peripheral speed of the perforating roll 2, so that part 10 of the foil is stretched. At the same time, the edges of the perforations are pulled apart. If in Figures 4, 6 and 8 the arrows 12 show the direction of pull to which the foil is subjected, the pull produces the holes 13 from the perforations 6, the holes 14 from the perforations 7 and the holes 15 from the perforations 8 of Figures 5, 7 and 9.

The peripheral speed of the tension roll pair 11, 11 is preferably adjustable, and may be so set in relation to the peripheral speed of the roll pair 2, 4 that the foil is stretched to its condition of maximum strength.

The heating of the foil may be effected by subjecting the foil to heat radiation at 16 before it enters the roll pair 2, 4; while between the two roll pairs an air stream 17 provides for the cooling of the foil, so that the perforations are fixed in the form shown in Figures 5, 7 or 9.

It is also possible to soften the foil by heating of the rolls 2, 4, for example by electrical heating of the rolls. On the other hand, the foil may be initially heated to a temperature substantially in excess of that required during the stretching operation, and the roll pair 2, 4 may be used for cooling the foil, by the introduction of cooling water, to the required temperature for stretching, the further cooling to fix the foil resulting from loss of heat to the surrounding atmosphere.

The roll 4, as well as the roll 2, may be in the form of a perforating roll.

Figure 3 shows substantially the same arrangement as Figure 1, but with the difference that the foil, initially moving in the direction of the arrow 18 is deflected from its original plane 19 into another plane 20, which according to Figure 3 is at right angles to the plane 19. By means of such an arrangement, the pressure of the cutters 3 against the foil is increased to such an extent that in certain cases the co-operating roll 4 may be omitted, unless it is constructed merely as pressure roll but not as a perforating roll.

In addition, however, the cutters 21, which perforate the foil within its bent part, due to the pulling effect of the tension rolls 11, the peripheral speed of which of course is higher than that of the perforating roll 2, exert, on a part of the edges of the perforations 6, 7 or 8, a tension having a component which is not directed in the plane of the foil. The trailing edges of the perforations in the foil are, as the foil passes around the perforating roll 2, bent by this tension out of the plane of the foil, so that those edges, as shown in Figure 10, form projections 22 which no longer lie in the plane 20 of the foil. If by means of the cooling air stream 17 provision is made for these projections to be fixed, they remain preserved after passing the tension rolls 11.

By variation of the cutter profile and hence the form of the perforations, it is possible to produce plastic foils with widely varying perforations, more particularly it is also possible to mount on a perforating roll different cutter profiles and to allow the two rolls 2, 4 as perforating rolls with different cutter profiles to operate simultaneously on one foil.

Furthermore, the spacing of the perforations both in the tension direction of the foil and transversely thereof may be varied. The spacing of the perforations may be made very small, so that after stretching, the holes have an area substantially equal to or even greater than that of the remaining parts of the foil. The result is then no longer a perforated foil of thermoplastic material but a net of that material. If the spacing of the perforations before stretching is of the order of magnitude of the thickness of the foil, a net is obtained, the threads of which have a substantially square cross section.

The perforated foil and nets of thermoplastic material which can be produced according to the invention may be used for many different technical or other purposes.

Stretching of the foil may be effected in one operation after perforation, as already described, but it may also be carried out in two or more stages. The foil may be stretched partly before perforation and for the other part during or after perforation. The process may, however, also be carried out by stretching partly during and partly after perforation.

Referring now to Figures 11 and 12 of the drawings, the thermoplastic material is fed from an extruder 23 through a wide sheeting die 24 into the open, and is then engaged by a roll pair 25, 26 corresponding to the roll pair 2, 4 previously described, one or both of the rolls 25, 26 being a perforating roll. The lower roll 26 runs in a liquid bath 27 for wetting or partially cooling the foil and thus preventing sticking of the foil. If necessary, the upper roll 25 may also be wetted, for example by liquid dropping on it.

The foil then passes further into a lateral stretching device 30 which will be described more fully later.

If the foil is to be coloured, it is passed through a colouring bath 28 and then through a water bath 29, for removing colour which has not adhered firmly to it. The colouring bath should be heated to ensure permanent absorption of the colour by the foil. So that the foil will be guided correctly through the two baths, deflecting rollers 31 are situated at the edges of the baths and deflecting rollers 32 in the depth of the baths.

From the water bath the foil passes to a longitudinal stretching device consisting of two rolls 33 and 34. By means of this longitudinal stretching device, the foil is so stretched in the manner previously described that the perforations produced by the rolls 25 and 26 are opened or enlarged. After passing the longitudinal stretching device, the foil passes through a second longitudinal stretching device constituted by two further rolls 35 and 36, the peripheral speed of which is higher than that of the rolls 33 and 34. The foil is thereby stretched once more and this second stretching is so selected that the now perforated or net-like foil is given the maximum possible strength. This degree of stretch is situated shortly before the rupturing point of the foil.

When the perforated foil 37 enters the lateral stretching device Fig. 12, it is engaged by two pairs of superimposed transport rollers, one pair 38 of which is arranged on one side of the foil width, and the other pair 39 on the other side. The transport rollers forming each pair have their axes parallel one to the other and inclined outwardly in the direction of travel of the foil, the ends of the two pairs of rollers which are nearest to the perforating roll being so spaced that the foil edges are engaged by them, and the rotation of the rollers tending to pull the edges of the foil apart as it travels towards their other ends. These transport rollers are provided with roughening elements, for example with a layer of sand or rubber fixed thereon. It is also

possible, however, to provide rows of small hooks, which hook into the edges of the foil and then release the foil again. At the points of admission 41 and 42 to the pairs of rollers 38 and 39, respectively, the edges of the foil 37 are seized and drawn apart laterally by the said rollers. At the points 43 and 44, the widened foil is released by the rollers 38 and 39 and then continues its onward passage with its new width further through the colouring bath 28 and the water bath 29. The foil is subjected to longitudinal tension between the rollers 25, 26 and the rollers 33, 34, the tension causing longitudinally stretching of the foil which commences as soon as it leaves the rollers 25, 26 and continues until, due to loss of heat to the surrounding atmosphere, it is too cool to be further stretched by the tension applied. After the foil has passed between the rollers 33, 34, a higher tension is applied to it by the further rolls 35, 36 to produce further stretching in its cooled condition. The lateral first stretching device should stretch the foil laterally so much that after stretching by the rolls 33 and 34 and 35 and 36, when it loses width, it has the finally desired width. The transport rollers of the lateral stretching device may be replaced by endless bands running over rollers.

WHAT WE CLAIM IS:—

1. A process for the production of perforated foils and nets from foil of thermoplastic material provided with perforations wherein the perforated foil is stretched in a hot condition and cooled whilst still subjected to the stretching force.

2. A process according to Claim 1, wherein the foil is stretched to a condition of maximum strength.

3. A process according to Claims 1 or 2, wherein the foil is heated before the perforations are formed therein.

4. A process according to Claim 3, wherein some stretching of the foil is carried out before or during its perforation.

5. A process according to Claims 1 or 2, wherein the heating of the foil is effected during or after perforation thereof.

6. A process according to any preceding Claim, wherein the edges of the perforations in the foil are at least partly displaced from the plane of the foil whilst the latter is in the hot condition, and are fixed in the displaced condition by cooling.

7. A process according to Claim 6 wherein the displacement of the edges of the perforations takes place simultaneously with the forming of the perforations.

8. A process according to Claims 6 or 7, wherein the stretching of the foil and the spreading out of the perforation edges take place during deflection of the foil from one plane into a plane at an angle thereto.

9. A process according to any preceding Claim, wherein the foil of thermoplastic material is passed over a perforating roll which forms the perforations and then through a tension roll pair having a higher peripheral speed than the perforating roll.

10. A process according to Claim 9, wherein the perforating roll forms one of a roll pair of which the other roll is a second perforating roll or a plain roll.

11. A process according to Claims 9 or 10, wherein means are provided for heating or cooling the rolls.

12. A process according to any preceding Claim wherein the foil is heated by radiation.

13. A process according to any preceding Claim, wherein the foil is strengthened by air cooling.

14. A process according to any preceding Claim, wherein the foil of thermoplastic material is subjected to further stretching after it has been cooled.

15. A process according to Claim 14, wherein the stretching before or after cooling is carried out in two directions at right angles to each other.

16. A process according to Claim 15, wherein one stretching takes place in the direction of feed of the foil and the other at right angles thereto.

17. A process according to Claim 16, wherein the stretching at right angles to the direction of feed of the foil is effected by pairs of rollers, or bands passing over rollers, the rollers having their axes of rotation at an acute angle to the feed direction of the foil and directed at a diverging angle to each other in the said feed direction, the said rollers or bands drawing the foil in the direction of their axes and releasing it after attaining the required degree of stretch.

18. A process according to Claims 9 or 10, wherein the foil is passed from an extruder through a wide sheeting die and then over the perforating roll or rolls whilst still in a plastic condition.

19. A process according to any preceding Claim wherein at least some of the rolls, particularly the perforating rolls, are wetted with a liquid, for example water.

20. A process according to Claim 19, wherein the perforating roll, or one of them, runs in a water bath.

21. A process according to any preceding Claim, wherein the foil is wetted with colour when in the warm or hot condition.

22. A process according to Claim 21, wherein the foil is drawn through a colouring bath.

23. Apparatus for carrying out the process as claimed in any preceding Claim, comprising a perforating roll or rolls driven at a low peripheral speed, a pair of tension rolls driven at a higher peripheral speed,

means for heating the foil before, during or after its passage over or between the perforating roll or rolls, and means for cooling the foil after heating and perforation and before it passes between the tension rolls.

24. Apparatus according to Claim 23, wherein the relative speed of the perforating roll or rolls and of the tension rolls is adjustable.

25. Apparatus according to Claims 23 or 24, wherein a single perforating roll is paired with a roll having a flexible coating.

26. Apparatus according to Claims 23 or 24 wherein two perforating rolls are paired one with the other.

27. Apparatus according to any of Claims 23 to 26, wherein cutters having different knife edge forms are provided for the perforating roll or rolls.

28. Apparatus according to any of Claims 23 to 27, wherein the perforating rolls are readily interchangeable.

29. Apparatus according to Claims 27 or 28, wherein the cutters on the perforating rolls are readily interchangeable.

30. Apparatus according to any of Claims 23 to 29, wherein the heating means for acting on the foil of thermoplastic material are provided before the perforating roll or rolls.

31. Apparatus for carrying out the process claimed in Claims 14 to 17, comprising an extruder, a wide sheeting die receiving thermoplastic material from the extruder, a perforating roll pair the rolls of which are wetted by a liquid, a lateral stretching device, a first longitudinal stretching device, and a curved longitudinal stretching device through which the foil is passed in succession after leaving the sheeting die.

32. Apparatus according to Claim 31, wherein a colouring bath and a water bath are interposed between the perforating roll pair and the longitudinal stretching device.

33. Apparatus according to Claim 32, wherein deflecting rollers are provided at the inlet and outlet edges, and in the interior, of the colouring and water baths.

34. Apparatus according to any of Claims 31 to 33, wherein the lateral stretching device comprises roller pairs or bands running over roller pairs arranged adjacent the feed path of the foil, one on each side thereof, the axes of the rollers diverging in the direction of the travel of the foil and the rollers or bands being provided with means for gripping the edges of the foil.

35. Apparatus according to Claim 34, wherein the rollers or bands of the lateral stretching devices are roughened or provided with hooks to grip the edges of the foil.

36. The process for producting a perforated foil or net of thermoplastic material substantially as herein described.

37. A perforated foil or net of thermoplastic material produced by the process herein described.

38. Apparatus for producing a perforated foil or net of thermoplastic material substantially as described with reference to, and as shown in, Figure 1, Figure 3 or Figures 11 and 12 of the accompanying drawings.

For the Applicants:—

F. J. CLEVELAND & COMPANY,
Chartered Patent Agents,
29, Southampton Buildings,
Chancery Lane, London, W.C.2.

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3 SHEETS

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SHEET 1

FIG. 1.

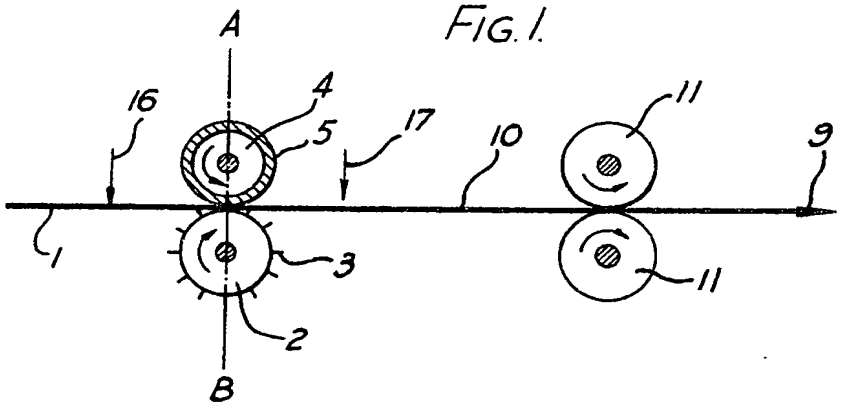
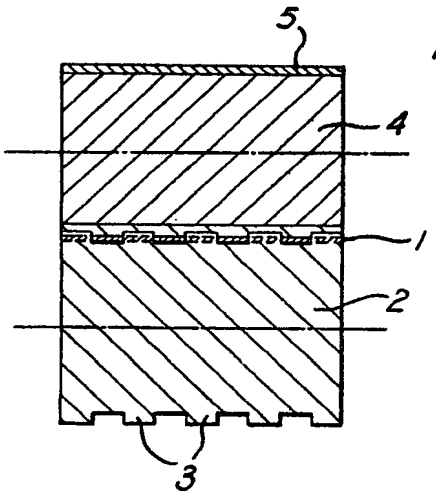


FIG. 2.



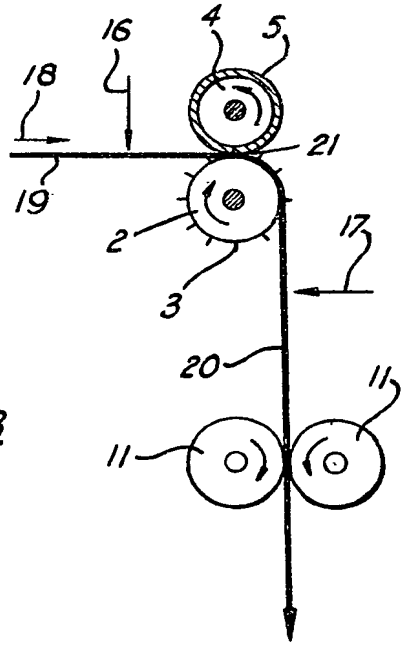


FIG. 3.

FIG. 4.

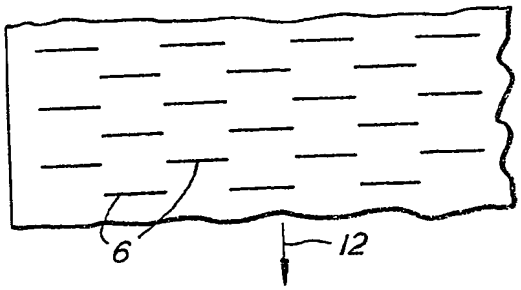


FIG. 5

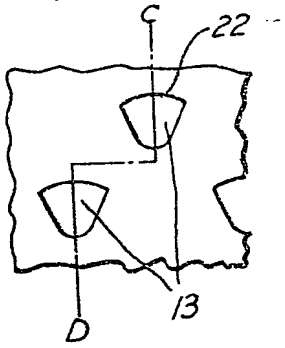


FIG. 6.

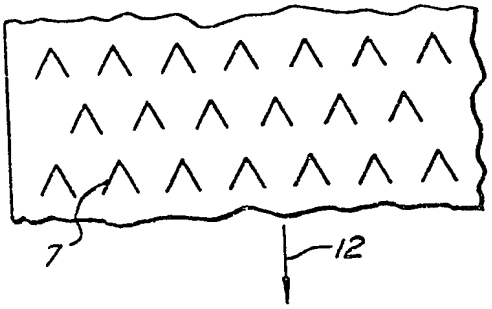


FIG. 7.

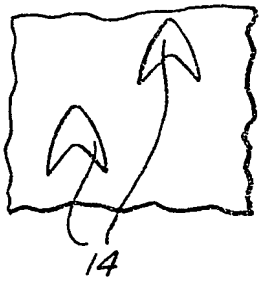


FIG. 8.

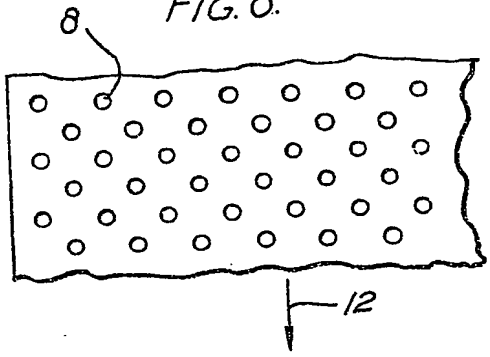
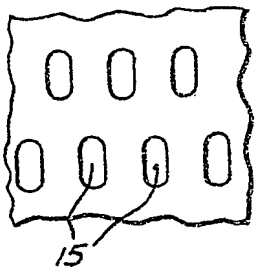


FIG. 9.



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SHEETS 2 & 3

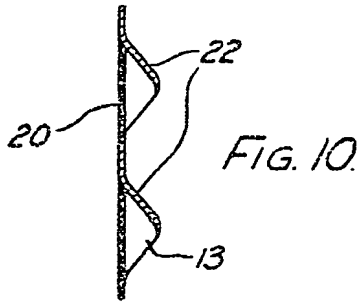


FIG. 10.

FIG. 11.

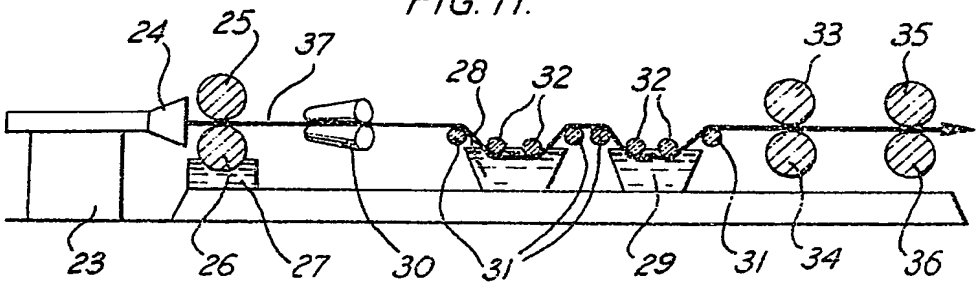
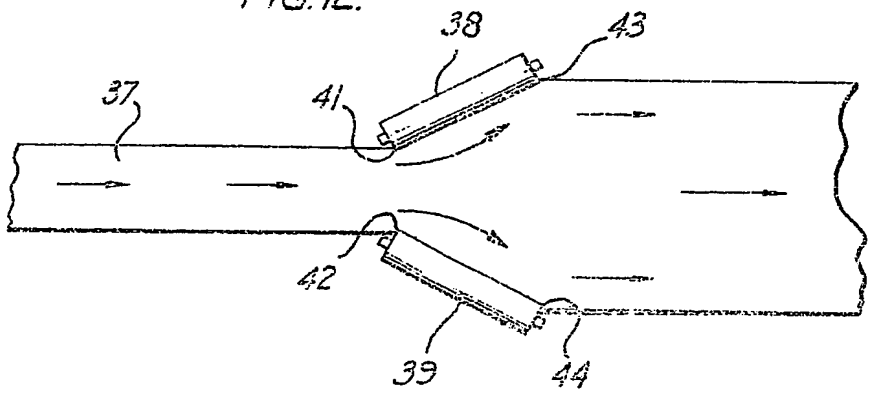


FIG. 12.



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SHEETS 2 & 3

FIG. 4.

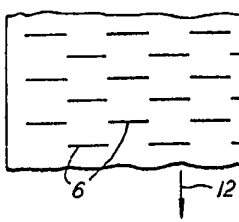


FIG 5

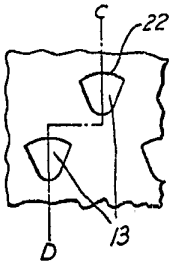


FIG. 6.

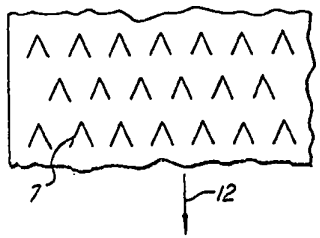


FIG 7.

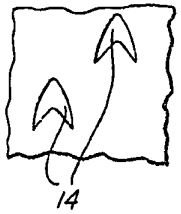


FIG. 8.

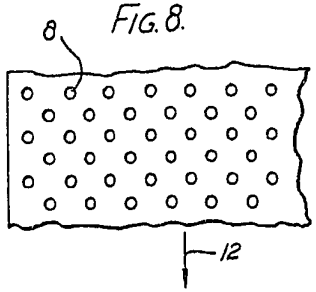
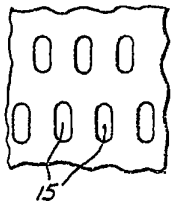


FIG. 9.



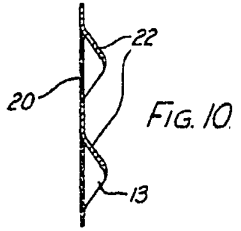


FIG. 10.

FIG. 11.

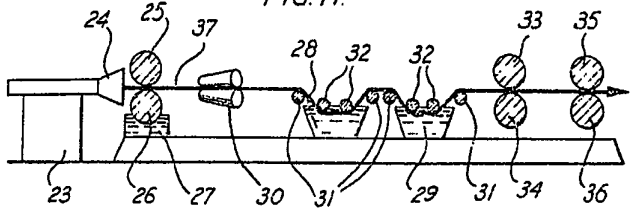


FIG. 12.